Exhibit 2

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APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY.DOCKET.NO	TOT CLAIMS	IND CLAIMS
61/521,263	08/08/2011		220	P001.12 (78120.0014)		

CONFIRMATION NO. 1904

16565
Holland & Hart LLP (ViaSat)
P.O. Box 8749
Denver, CO 80201

FILING RECEIPT

OC000000049400951

Date Mailed: 08/24/2011

Receipt is acknowledged of this provisional patent application. It will not be examined for patentability and will become abandoned not later than twelve months after its filing date. Any correspondence concerning the application must include the following identification information: the U.S. APPLICATION NUMBER, FILING DATE, NAME OF APPLICANT, and TITLE OF INVENTION. Fees transmitted by check or draft are subject to collection. Please verify the accuracy of the data presented on this receipt. **If an error is noted on this Filing Receipt, please submit a written request for a Filing Receipt Correction. Please provide a copy of this Filing Receipt with the changes noted thereon. If you received a "Notice to File Missing Parts" for this application, please submit any corrections to this Filing Receipt with your reply to the Notice. When the USPTO processes the reply to the Notice, the USPTO will generate another Filing Receipt incorporating the requested corrections**

Applicant(s)

Fan Mo, Hinckley, OH;
Sameep Dave, Hinckley, OH;

Power of Attorney:
Michael Drapkin--55127

If Required, Foreign Filing License Granted: 08/18/2011

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 61/521,263**

Projected Publication Date: None, application is not eligible for pre-grant publication

Non-Publication Request: No

Early Publication Request: No

Title

FRAME FORMATTING FOR HIGH RATE OPTICAL COMMUNICATIONS

PROTECTING YOUR INVENTION OUTSIDE THE UNITED STATES

Since the rights granted by a U.S. patent extend only throughout the territory of the United States and have no effect in a foreign country, an inventor who wishes patent protection in another country must apply for a patent in a specific country or in regional patent offices. Applicants may wish to consider the filing of an international application under the Patent Cooperation Treaty (PCT). An international (PCT) application generally has the same effect as a regular national patent application in each PCT-member country. The PCT process **simplifies** the filing of patent applications on the same invention in member countries, but **does not result** in a grant of "an international

patent" and does not eliminate the need of applicants to file additional documents and fees in countries where patent protection is desired.

Almost every country has its own patent law, and a person desiring a patent in a particular country must make an application for patent in that country in accordance with its particular laws. Since the laws of many countries differ in various respects from the patent law of the United States, applicants are advised to seek guidance from specific foreign countries to ensure that patent rights are not lost prematurely.

Applicants also are advised that in the case of inventions made in the United States, the Director of the USPTO must issue a license before applicants can apply for a patent in a foreign country. The filing of a U.S. patent application serves as a request for a foreign filing license. The application's filing receipt contains further information and guidance as to the status of applicant's license for foreign filing.

Applicants may wish to consult the USPTO booklet, "General Information Concerning Patents" (specifically, the section entitled "Treaties and Foreign Patents") for more information on timeframes and deadlines for filing foreign patent applications. The guide is available either by contacting the USPTO Contact Center at 800-786-9199, or it can be viewed on the USPTO website at http://www.uspto.gov/web/offices/pac/doc/general/index.html.

For information on preventing theft of your intellectual property (patents, trademarks and copyrights), you may wish to consult the U.S. Government website, http://www.stopfakes.gov. Part of a Department of Commerce initiative, this website includes self-help "toolkits" giving innovators guidance on how to protect intellectual property in specific countries such as China, Korea and Mexico. For questions regarding patent enforcement issues, applicants may call the U.S. Government hotline at 1-866-999-HALT (1-866-999-4158).

LICENSE FOR FOREIGN FILING UNDER

Title 35, United States Code, Section 184

Title 37, Code of Federal Regulations, 5.11 & 5.15

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Security, Department of Commerce (15 CFR parts 730-774); the Office of Foreign AssetsControl, Department of Treasury (31 CFR Parts 500+) and the Department of Energy.

NOT GRANTED

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Doc Code: TR.PROV
Document Description: Provisional Cover Sheet (SB16)

PTO/SB/16 (11-08)
Approved for use through 09/30/2010 OMB 0651-0032
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Provisional Application for Patent Cover Sheet

This is a request for filing a PROVISIONAL APPLICATION FOR PATENT under 37 CFR 1.53(c)

Inventor(s)

Inventor 1 — Remove

Given Name	Middle Name	Family Name	City	State	Country
Fan		Mo	Hinckley	OH	US

Inventor 2 — Remove

Given Name	Middle Name	Family Name	City	State	Country
Sameep		Dave	Hinckley	OH	US

All Inventors Must Be Listed – Additional Inventor Information blocks may be generated within this form by selecting the **Add** button. Add

Title of Invention	FRAME FORMATTING FOR HIGH RATE OPTICAL COMMUNICATIONS
Attorney Docket Number (if applicable)	P001.12 (78120.0014)

Correspondence Address

Direct all correspondence to (select one):

◉ The address corresponding to Customer Number	○ Firm or Individual Name
Customer Number	16565

The invention was made by an agency of the United States Government or under a contract with an agency of the United States Government.

◉ No.

○ Yes, the name of the U.S. Government agency and the Government contract number are:

Doc Code: TR.PROV
Document Description: Provisional Cover Sheet (SB16)

PTO/SB/16 (11-08)
Approved for use through 09/30/2010 OMB 0651-0032
U.S. Patent and Trademark Office: U.S. DEPARTMENT OF COMMERCE
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Entity Status

Applicant claims small entity status under 37 CFR 1.27

◯ Yes, applicant qualifies for small entity status under 37 CFR 1.27

◉ No

Warning

Petitioner/applicant is cautioned to avoid submitting personal information in documents filed in a patent application that may contribute to identity theft. Personal information such as social security numbers, bank account numbers, or credit card numbers (other than a check or credit card authorization form PTO-2038 submitted for payment purposes) is never required by the USPTO to support a petition or an application. If this type of personal information is included in documents submitted to the USPTO, petitioners/applicants should consider redacting such personal information from the documents before submitting them to USPTO. Petitioner/applicant is advised that the record of a patent application is available to the public after publication of the application (unless a non-publication request in compliance with 37 CFR 1.213(a) is made in the application) or issuance of a patent. Furthermore, the record from an abandoned application may also be available to the public if the application is referenced in a published application or an issued patent (see 37 CFR1.14). Checks and credit card authorization forms PTO-2038 submitted for payment purposes are not retained in the application file and therefore are not publicly available.

Signature

Please see 37 CFR 1.4(d) for the form of the signature.

Signature	/Michael L. Drapkin/			Date (YYYY-MM-DD)	2011-08-08
First Name	Michael L.	Last Name	Drapkin	Registration Number (If appropriate)	55127

This collection of information is required by 37 CFR 1.51. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 8 hours to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **This form can only be used when in conjunction with EFS-Web. If this form is mailed to the USPTO, it may cause delays in handling the provisional application.**

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3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, t o a n other federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
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9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

PTO/SB/14 (11-08)
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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	P001.12 (78120.0014)
	Application Number	
Title of Invention	FRAME FORMATTING FOR HIGH RATE OPTICAL COMMUNICATIONS	

The application data sheet is part of the provisional or nonprovisional application for which it is being submitted. The following form contains the bibliographic data arranged in a format specified by the United States Patent and Trademark Office as outlined in 37 CFR 1.76.
This document may be completed electronically and submitted to the Office in electronic format using the Electronic Filing System (EFS) or the document may be printed and included in a paper filed application.

Secrecy Order 37 CFR 5.2

☐ Portions or all of the application associated with this Application Data Sheet may fall under a Secrecy Order pursuant to 37 CFR 5.2 (Paper filers only. Applications that fall under Secrecy Order may not be filed electronically.)

Applicant Information:

Applicant 1 Remove

Applicant Authority ◉ Inventor ○ Legal Representative under 35 U.S.C. 117 ○ Party of Interest under 35 U.S.C. 118

Prefix	Given Name	Middle Name	Family Name	Suffix
	Fan		Mo	

Residence Information (Select One) ◉ US Residency ○ Non US Residency ○ Active US Military Service

City	Hinckley	State/Province	OH	Country of Residence[i]	US

Citizenship under 37 CFR 1.41(b)[i] CN

Mailing Address of Applicant:

Address 1	6155 El Camino Real		
Address 2			
City	Carlsbad	State/Province	CA
Postal Code	92009-1699	Country[i]	US

Applicant 2 Remove

Applicant Authority ◉ Inventor ○ Legal Representative under 35 U.S.C. 117 ○ Party of Interest under 35 U.S.C. 118

Prefix	Given Name	Middle Name	Family Name	Suffix
	Sameep		Dave	

Residence Information (Select One) ◉ US Residency ○ Non US Residency ○ Active US Military Service

City	Hinckley	State/Province	OH	Country of Residence[i]	US

Citizenship under 37 CFR 1.41(b)[i] IN

Mailing Address of Applicant:

Address 1	6155 El Camino Real		
Address 2			
City	Carlsbad	State/Province	CA
Postal Code	92009-1699	Country[i]	US

All Inventors Must Be Listed - Additional Inventor Information blocks may be generated within this form by selecting the **Add** button. Add

Correspondence Information:

Enter either Customer Number or complete the Correspondence Information section below.
For further information see 37 CFR 1.33(a).

☐ **An Address is being provided for the correspondence Information of this application.**

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	P001.12 (78120.0014)
	Application Number	
Title of Invention	FRAME FORMATTING FOR HIGH RATE OPTICAL COMMUNICATIONS	

Customer Number	16565		
Email Address	patentdocket@hollandhart.com	Add Email	Remove Email

Application Information:

Title of the Invention	FRAME FORMATTING FOR HIGH RATE OPTICAL COMMUNICATIONS		
Attorney Docket Number	P001.12 (78120.0014)	**Small Entity Status Claimed**	☐
Application Type	Provisional		
Subject Matter	Utility		
Suggested Class (if any)		**Sub Class (if any)**	
Suggested Technology Center (if any)			
Total Number of Drawing Sheets (if any)	9	**Suggested Figure for Publication (if any)**	

Publication Information:

☐ Request Early Publication (Fee required at time of Request 37 CFR 1.219)

☐ **Request Not to Publish.** I hereby request that the attached application not be published under 35 U.S. C. 122(b) and certify that the invention disclosed in the attached application **has not and will not** be the subject of an application filed in another country, or under a multilateral international agreement, that requires publication at eighteen months after filing.

Representative Information:

Representative information should be provided for all practitioners having a power of attorney in the application. Providing this information in the Application Data Sheet does not constitute a power of attorney in the application (see 37 CFR 1.32). Enter either Customer Number or complete the Representative Name section below. If both sections are completed the Customer Number will be used for the Representative Information during processing.

Please Select One:	◉ Customer Number	○ US Patent Practitioner	○ Limited Recognition (37 CFR 11.9)
Customer Number	16565		

Domestic Benefit/National Stage Information:

This section allows for the applicant to either claim benefit under 35 U.S.C. 119(e), 120, 121, or 365(c) or indicate National Stage entry from a PCT application. Providing this information in the application data sheet constitutes the specific reference required by 35 U.S.C. 119(e) or 120, and 37 CFR 1.78(a)(2) or CFR 1.78(a)(4), and need not otherwise be made part of the specification.

Prior Application Status			Remove
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)

Additional Domestic Benefit/National Stage Data may be generated within this form by selecting the **Add** button. Add

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	P001.12 (78120.0014)
	Application Number	
Title of Invention	FRAME FORMATTING FOR HIGH RATE OPTICAL COMMUNICATIONS	

This section allows for the applicant to claim benefit of foreign priority and to identify any prior foreign application for which priority is not claimed. Providing this information in the application data sheet constitutes the claim for priority as required by 35 U.S.C. 119(b) and 37 CFR 1.55(a).

Remove

Application Number	Country [i]	Parent Filing Date (YYYY-MM-DD)	Priority Claimed
			◯ Yes ◉ No

Additional Foreign Priority Data may be generated within this form by selecting the **Add** button. Add

Assignee Information:

Providing this information in the application data sheet does not substitute for compliance with any requirement of part 3 of Title 37 of the CFR to have an assignment recorded in the Office.

Assignee 1 Remove

If the Assignee is an Organization check here. ☒

Organization Name	ViaSat, Inc.		
Mailing Address Information:			
Address 1	6155 El Camino Real		
Address 2			
City	Carlsbad	**State/Province**	CA
Country [i]	US	Postal Code	92009-1699
Phone Number		Fax Number	
Email Address			

Additional Assignee Data may be generated within this form by selecting the **Add** button. Add

Signature:

A signature of the applicant or representative is required in accordance with 37 CFR 1.33 and 10.18. Please see 37 CFR 1.4(d) for the form of the signature.

Signature	/Michael L. Drapkin/			Date (YYYY-MM-DD)	2011-08-08
First Name	Michael L.	Last Name	Drapkin	Registration Number	55127

This collection of information is required by 37 CFR 1.76. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 23 minutes to complete, including gathering, preparing, and submitting the completed application data sheet form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these records.

2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.

3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.

4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).

5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.

6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).

7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.

8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.

9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

PATENT
ViaSat Docket No: ECC-0452-US-12
Attorney Docket No.: P001.12 (78120.0014)

FRAME FORMATTING FOR HIGH RATE OPTICAL COMMUNICATIONS

BACKGROUND

[0001] The present disclosure relates to systems, devices, and methods for demodulation in fiber optic communications systems.

[0002] Fiber optic channels in network communications systems are widely deployed and are considered effective for data transmission, allowing relatively high bandwidth data communication. Optical fiber is typically flexible and can be bundled in cables. It is often used for long-distance communications because light propagates through the fiber with little attenuation compared to electrical cables. Typical present day commercial optical fiber systems transmit data at 10 or 40 Gbps. Each fiber can carry multiple independent channels, each using a different wavelength of light in a technique known as wavelength-division multiplexing (WDM).

[0003] Increased data transmission rates would be desirable as demand for bandwidth increases. However, in fiber optic systems, as data rates increase various optical phenomena begin to manifest and act to limit data transmission rates. For example, optical effects from chromatic dispersion (CD), polarization mode dispersion (PMD), and polarization dependent loss (PDL) begin to have a significant impact on the data transmission rate.

SUMMARY

[0004] Methods, systems, devices, and computer program products are described for formatting of data streams to be transmitted over fiber optic channels, and for processing received optical signals. An exemplary data transmission device may include a digital coding and modulation module that encodes a digital data stream, inserts unique words into the digital data stream, and modulates the encoded data stream and unique words onto a plurality of optical channels for transmission over an optical fiber. An exemplary demodulator and decoding device may include a unique word identification module that identifies the unique words inserted in each optical channel stream, determines one or more characteristics of the

plurality of optical channels based on the unique words, and provides the one or more characteristics to one or more other modules in the demodulator and decoding device. Other functionality may be implemented, as described in more detail below.

BRIEF DESCRIPTION OF THE DRAWINGS

[0005] A further understanding of the nature and advantages of the present invention may be realized by reference to the following drawings. In the appended figures, similar components or features may have the same reference label. Further, various components of the same type may be distinguished by following the reference label by a dash and a second label that distinguishes among the similar components. If only the first reference label is used in the specification, the description is applicable to any one of the similar components having the same first reference label irrespective of the second reference label.

[0006] FIG. 1 is a block diagram of an optical communication system including components configured according to various embodiments of the invention.

[0007] FIG. 2 is a block diagram of a digital coding and modulation unit according to various embodiments of the invention.

[0008] FIG. 3 is a block diagram of an alternate digital coding and modulation unit according to various embodiments of the invention.

[0009] FIG. 4 is a block diagram of exemplary incoming and outgoing streams from a unique word insertion module, differential encoding module, and associated transmission optical interface module according to various embodiments of the invention.

[0010] FIG. 5 is a illustration of a bit stream used to insert unique words into dual-polarity QPSK channels block diagram of a digital coding and modulation unit according to various embodiments of the invention.

[0011] FIG. 6 is a block diagram of a digital demodulation and decoding unit according to various embodiments of the invention.

[0012] FIG. 7 is a block diagram of a digital demodulation unit according to various embodiments of the invention.

[0013] FIG. 8 is a flow chart of a method for inserting a unique word into optical streams to be transmitted over optical fibers according to various embodiments of the invention.

[0014] FIG. 9 is a flow chart of a method for digital demodulation of optical signals based on signal characteristics determined from identification of unique words present on a plurality of optical channels according to various embodiments of the invention.

DETAILED DESCRIPTION OF THE INVENTION

[0015] Methods, systems, devices, and computer program products are described for formatting of data streams to be transmitted over fiber optic channels, and for processing received optical signals. An exemplary data transmission device may include a digital coding and modulation module that encodes a digital data stream, inserts unique words into the digital data stream, and modulates the encoded data stream and unique words onto a plurality of optical channels for transmission over an optical fiber. An exemplary demodulator and decoding device may include a unique word identification module that identifies the unique words inserted in each optical channel stream, determines one or more characteristics of the plurality of optical channels based on the unique words, and provides the one or more characteristics to one or more other modules in the demodulator and decoding device. Additional functionality may be implemented, as described in more detail below.

[0016] This description provides examples, and is not intended to limit the scope, applicability or configuration of the invention. Rather, the ensuing description will provide those skilled in the art with an enabling description for implementing embodiments of the invention. Various changes may be made in the function and arrangement of elements.

[0017] Thus, various embodiments may omit, substitute, or add various procedures or components as appropriate. For instance, it should be appreciated that the methods may be performed in an order different than that described, and that various steps may be added, omitted or combined. Also, aspects and elements described with respect to certain embodiments may be combined in various other embodiments. It should also be appreciated that the following systems, methods, devices, and software may individually or collectively be components of a larger system, wherein other procedures may take precedence over or otherwise modify their application.

[0018] Systems, devices, methods, and software are described for an optical communication system that utilizes fiber optic optical cables as a data transmission medium. An example of an optical data transport system 100 is illustrated in **FIG. 1**. In this embodiment, the optical data transport system 100 includes a data source that provides data

to a digital coding and modulation unit 105. The data source may include any of a number of common data sources, such as a user telecommunications device, a cable operator head-end unit, a telecommunications provider central office, a computer server, or a network attached storage system, to name but a few examples. In many embodiments, the data source generates significant quantities of data to be transported across the optical data transport system 100. The digital coding and modulation unit 105 receives this data, and performs framing, forward error correction coding, and modulation functions on the data. In various embodiments, the digital coding and modulation unit 105 inserts a unique word into the data stream for each optical channel over which data will be sent. The electrical-to-optical (E-O) unit 110 transforms the data and inserted unique words into optical signals, and transmits optical signals containing the data via a fiber connection 115. The fiber connection 115 may include well known components of such connections, including a fiber optic cable. An optical-to-electrical (O-E) unit 120 receives the optical signal from the fiber connection 115, and transforms the data into the electrical domain. The digital demodulation and decoding unit 120 receives the digitized version of the optical signal and detects the unique words that are inserted onto each optical channel. The detection of the unique words on each channel can be used to provide characteristics of the optical channels that may be used to the digital demodulation and decoding unit 120 when performing demodulation, forward error correction decoding, and de-framing functions on the data from the optical signal. The digital demodulation and decoding unit 120 may then output the data (e.g., to a user telecommunications device, a cable operator head-end unit, a telecommunications provider central office, a computer server, or a network attached storage system).

[0019] **FIG. 2** illustrates a digital coding and modulation unit 105-a. In the illustrated embodiment, the digital coding and modulation unit 105-a includes a data transport layer framer module 205, a FIFO module 210, an FEC coder module 215, an interleaving module 220, a unique word insertion module 225, a differential encoding module 230, and a transmitter optical interface module 235. The data transport layer framer module 205 may place the data received from the data source into packet frames for transmission. The packet frames may conform to one of many common protocols for packet frames used in optical communications systems which commonly include a header and a payload, and possibly a trailer, such as a CRC. As is well understood, the header may be interleaved with the payload during transmission, depending upon the particular protocol being used for optical transmission. The FIFO module 210 queues the packet frames received from the data

transport layer framer module 205. The FEC coder module 215 calculates and adds forward error correction (FEC) information to the frames of data received from the data transport layer framer module 205. The particular type of FEC information of various embodiments generally includes systematically generated redundant error-correcting code (ECC) data that is transmitted along with the frames, and in an embodiment FEC information includes turbo product code (TPC) information. Interleaving module 220, in the embodiment of Fig. 2, receives the FEC information and frames of data, and interleaves the FEC information with the frames of data to reduce the likelihood of a channel error removing all FEC data for a particular frame. Unique word insertion module 225, in the embodiment of Fig. 2, inserts unique words into the data stream received from the interleaving module 220. Unique words may be added to each transmitted optical channel to assist with the decoding and demodulation of the optical signals containing different streams of data. In one embodiment, the interleaved frames of data are modulated using dual-polarity (dual-pole) quadrature-phase-shift-keying (QPSK), resulting in four optical channels. The unique word insertion module 225 of this embodiment inserts a unique word into the data stream for each of the four optical channels. The inserted unique word is a different unique word for each optical channel, that is inserted into the data stream for the optical channel periodically. Differential encoding module 230 provides differential encoding for the interleaved FEC encoded frames and unique words. Differential encoding is a well known technique in which data to be transmitted depend not only on the current bit (or symbol), but also on the previous one, such as through an exclusive OR function. The differentially encoded data is then provided to the transmitter optical interface module 235. The transmitter optical interface module 235 may forward the modulated data to the E-O module (Fig. 1) where it may be transmitted in the optical domain via dual-pole QPSK modulation, resulting in four parallel optical streams. Other modulation schemes may be used in other examples, as well.

[0020] As will be readily understood by one of skill in the art, the particular arrangement of the modules of FIG. 2 are exemplary, and the particular order in which data is processed may vary, and particular functions of various modules may be modified and/or combined. An exemplary alternative configuration of a digital coding and modulation unit 105-b is illustrated in **FIG. 3**. In this exemplary embodiment, the digital coding and modulation unit 105-b includes the modules as described with respect to digital coding and modulation unit 105-a of FIG. 2, arranged in an alternate order. In the example of FIG. 3, the digital coding and modulation unit 105-b includes a data transport layer framer module 305, a FIFO module

310, an FEC coder module 315, an interleaving module 320, a differential encoding module 325, a unique word insertion module 330, and a transmitter optical interface module 335. In this particular example, differential encoding module 325 receives data from interleaving module 320. Differential encoding module 325 provides differential encoding for the interleaved FEC encoded frames, which is then provided to unique word insertion module 330. Unique word insertion module 330, in the embodiment of FIG. 3, inserts unique words into the differentially encoded data stream received from the differential encoding module 325. Similarly as discussed with respect to FIG. 2, unique words may be added to each transmitted optical channel to assist with the decoding and demodulation of the optical signals containing different streams of data. In one embodiment, the interleaved frames of data are modulated using dual-pole QPSK, resulting in four optical channels, and the unique word insertion module 330 inserts a unique word into the data stream for each of the four optical channels, and provide the data stream to the transmitter optical interface module 335. In the embodiment of FIG. 3, the transmitter optical interface module 335 modulates the data onto a number of optical channels and forwards the modulated data to the E-O module (Fig. 1) where it may be transmitted in the optical domain via dual-pole QPSK modulation, resulting in four parallel optical streams. Other modulation schemes may be used in other examples, as well.

[0021] The unique word insertion module 225 of FIG. 2, as briefly discussed, inserts a unique word into each data stream corresponding to each transmitted optical channel. It is noted that unique word insertion module 330 of FIG. 3 operates in a similar manner, and various aspects of the unique word insertion module 225 will be described in more detail with the understanding that such discussion applies equally to unique word insertion module 330. With reference now to **FIG. 4**, an illustration of incoming and outgoing data streams 400 of unique word insertion module 225-a, differential encoding module 230-a, and transmitter optical interface module 235-a, is described. In this example, an interleaved FEC encoded bit (or symbol) stream 405 is received at unique word insertion module 225-a. Similarly as described above, unique word insertion module 225-a inserts unique words into the stream 405, and provides the stream and unique words to differential encoding module 230-a, which provides a differentially encoded stream to transmitter optical interface module 235-a. The transmitter optical interface module 235-a may modulate the incoming data stream onto different optical channels according to various modulation techniques. In one example, the incoming data stream is modulated using dual-pole QPSK onto four different optical

channels, namely a horizontal in-phase (HI) channel, a horizontal quadrature (HQ) channel, vertical in-phase (VI) channel, and a vertical quadrature (VQ) channel. Data transmitted on each of the optical channels may be selected, for example, by taking a first received bit (or symbol) and modulating it onto the HI channel, taking the second received bit and modulating it onto the HQ channel, and so on. In such an embodiment, the unique word insertion module 225-a inserts unique word bits into the data stream periodically to produce output data streams for each channel that have periodic unique words embedded therein. The output from the transmitter optical interface module 235-a thus provides an HI data stream 410 that has a first unique word periodically included therein, an HQ data stream 415 that has a second unique word periodically included therein, a VI data stream 420 that has a third unique word periodically included therein, and a VQ data stream 425 that has a fourth unique word periodically included therein. Each of the first, second, third, and fourth unique words are selected to uniquely identify the particular data stream associated with the unique word. When the transmitted optical signals are received at a receiver, these unique words may be identified and assist with compensation and demodulation of received optical signals. In one embodiment, the unique words include pseudonoise (PN) code generated for the unique word in each data stream 410 through 425.

[0022] The unique word insertion module 225-a inserts bits of data into the incoming interleaved FEC encoded bit stream 405 such that data streams 410 through 425 each include the correct corresponding unique word. As mentioned, the transmitter optical interface module 235-a may modulate consecutively received bits onto separate HI, HQ, VI, and VQ data streams. In such a case, the unique word insertion module 225-a inserts a bit stream into the interleaved FEC encoded bit stream 405 in which each fourth bit corresponds to a particular unique word. An example of such a unique word insertion bit stream 500 is illustrated in **FIG. 5**. In this example, each unique word is n/4 bits in length, resulting in unique word insertion bit stream 500 that is n bits. These n bits are periodically inserted into the incoming interleaved FEC encoded bit stream 405 according to a predetermined interval, with bits 1, 5, 9, and so on through bit n-3 corresponding to the first unique word (UW1) of HI data stream 410. Likewise, bits 2, 6, 10, and so on through bit n-2 correspond to the second unique word (UW2) of HQ data stream 415; bits 3, 7, 11, and so on through bit n-1 correspond to the third unique word (UW3) of VI data stream 420; and bits 4, 8, 12, and so on through bit n correspond to the fourth unique word (UW4) of VQ data stream 425. Of course, other modulation techniques may be used in which data is modulated onto optical

channels according to different sequences, and the unique word insertion module 225-a provides the unique word insertion bit stream accordingly so as to provide each optical channel with a corresponding unique word.

[0023] As illustrated in **FIG. 6**, a digital demodulation and decoding unit 125-a may include a number of modules. In this embodiment the digital demodulation and decoding unit 125-a includes a receiver optical interface module 605, a unique word identification module 610, demodulator module 615, an FEC decoder module 620, and a data transport layer de-framer module 625. The receiver optical interface 605 is the interface from the O-E unit 120. The receiver optical interface module 605 provides electrical signals to a unique word identification module 610 that identifies the unique words that are inserted in each of the optical channel data streams. The unique word identification module 610 removes the unique words from each respective data stream, and determines information related to the received data streams that may be derived from the unique word identification, such as the particular received channel on which the unique words are identified, and the timing of the receipt of the unique words. This information may be provided to other modules for assistance in the demodulating and/or decoding of the received optical channels. The electrical signals, are provided from the unique word identification module 610 to demodulator module 615. Demodulator module 615 may include a differential decoding module that decodes differential encoding that may have been performed at digital coding and modulation module 105. Various embodiments of the demodulator module 615 will be discussed in further detail below. The information from the demodulator module 615 is provided to FEC decoder module 620 which decodes and may correct transmission errors identified from error-correcting code. The FEC decoder module 620 provides decoded data to the data transport layer de-framer module 625, which de-frames the data from the signal according to the particular protocol used in the optical transmission, and provides output data. The data output may be, for example, a user or any receiving system.

[0024] These components of may, individually or collectively, be implemented with one or more Application Specific Integrated Circuits (ASICs) adapted to perform some or all of the applicable functions in hardware. Alternatively, the functions may be performed by one or more other processing units (or cores), on one or more integrated circuits. In other embodiments, other types of integrated circuits may be used (e.g., Structured/Platform ASICs, Field Programmable Gate Arrays (FPGAs) and other Semi-Custom ICs), which may be programmed in any manner known in the art. The functions of each unit may also be

implemented, in whole or in part, with instructions embodied in a memory, formatted to be executed by one or more general or application-specific processors.

[0025] Referring now to **FIG. 7**, a demodulator unit 700 is described. This may be the digital demodulator unit 615 of FIG. 6. In this example, two polarization components are received, one horizontal component (H) and one vertical component (V). Each of the H and V components includes both an in-phase (I) component and a quadrature (Q) component. For reference, the two components in the horizontal polarization are referred to as HI (horizontal in-phase component) and HQ (horizontal quadrature component). Similarly, the two components in the vertical polarization are referred to as VI (vertical in-phase component) and VQ (vertical quadrature component). The demodulator unit 800 processes the digitized samples of the I and Q components of the two polarization components to recover the transmitted data. At the input, the demodulator unit 700 accepts the four parallel streams carrying HI, HQ, VI and VQ samples. In one embodiment, each stream contains multiple samples per clock. At its output the demodulator may provide demodulated hard-decision data (although in other examples, soft-decision data may be provided) to the FEC decoder module. The demodulator unit 700 may identify the beginning of a FEC frame. Additionally, in some embodiments the demodulator unit 700 receives feedback signals from the FEC decoder module 620 regarding the convergence status for error correction. Furthermore, in some embodiments the demodulator unit 700 receives information from unique word identification module 610 to assist in the demodulation.

[0026] In some embodiments, the demodulator unit 700 is implemented as an application specific integrated circuit (ASIC) that includes a number of functional modules. In such embodiments, the demodulator unit 700 may have a control and monitor interface bus 705 connected to a host processor 710 allowing for configuration of demodulator parameters (filter coefficients, loop gains, etc.) and extraction of demodulator status. With continuing reference to FIG. 7, several of the sub-modules within the demodulator unit 700 of various embodiments are described. In this embodiment, a quadrature error filter (QEF) module 715 provides a collection of data formatting, error detection and correction functions. In one embodiment, input data samples are expected to be in binary-offset /offset-binary format and are converted to a two's complement (2C) format for processing within a digital signal processor. The incoming HI, HQ, VI and VQ streams, in some embodiments, also can be independently swapped and inverted if needed, allowing for any design issues that might translate into an accidental inversion or IQ swap. Each data stream of these various

embodiments may be processed to remove polarization skew (between H and V poles) as well as I-Q skew within a pole. The QEF module 715 may provide for detection and removal of four types of quadrature signal errors: I/Q Skew, DC bias, I/Q amplitude imbalance, and I/Q phase imbalance. All four error detectors may be independently enabled or disabled, in some embodiments, via the processor interface, and the detected error values are output as status values via this same interface. The QEF module 715 may also output a gain control signal that may be used by other components of the system.

[0027] The QEF module 715 is connected with a frequency offset removal module 720. The frequency offset removal module 720 in one example performs a frequency rotation on the data samples coming out of the QEF module 715. The amount of frequency rotation is controlled by a frequency error input that is sourced by a carrier frequency acquisition and tracking (CFAT) module 740. Such frequency offset removal function may remove residual frequency left from the LO laser tuning in the optical domain. A chromatic dispersion compensation module 725 removes bulk chromatic dispersion from the horizontal and vertical polarization channels. The compensation may be applied via a filter in the frequency domain. The amount of correction may be controlled by the chromatic dispersion filter inputs that are derived outside of the demodulator module 700 and provided via the host processor 710 and control and monitor interface bus 705, in this embodiment.

[0028] A matched filter decimator (MFD) module 730 may implement an interpolation function that provides decimation on samples taken at two+ε times the symbol rate. In one embodiment, each of the four data streams has an independent bank of FIR filters with selected coefficients. The incoming data is processed through the filter banks to produce two samples per symbol for each data stream. Data samples are gathered and assembled into blocks of fixed numbers of samples per stream per clock by a sample block assembler. The assembly function may be identical for the I and Q streams in each polarization so one assembly block may service two streams. A PMD/PDL compensation module 735 may utilize adaptive equalization to compensate for cross-polarization interference, IQ channel interference, and adjacent symbol interference introduced by PMD and PDL in the optical channel and other residual impairments, such as residual chromatic dispersion as mentioned above. In one embodiment, an adaptive equalizer takes in data at one or two samples/symbols from the MFD module 730 and processes the data through a bank of FIR filters with adaptive filter tap coefficients.

[0029] In some embodiments, a symbol timing acquisition and tracking (STAT) module 745 may estimate symbol timing using an early/late symbol radius matching scheme and PI controller, and generate an error signal to correct symbol timing. This STAT module 745, in an embodiment, also has a symbol timing lock detection mechanism that outputs a symbol lock indicator. In various embodiments, there are two sets of gains for the PI controller (wide band for acquisition and narrow band for tracking). When not in timing lock, the wideband gains may be used, otherwise, the narrowband gains may be used. The STAT module 745 may perform symbol timing acquisition and tracking of a portion of the optical signal after the PMD/ PDL compensation module compensates for interference caused by PMD and PDL and before carrier phase recovery on the portion of the optical signal.

[0030] The CFAT module 740 may be responsible for acquiring, as well as tracking, carrier frequency. Carrier frequency acquisition is achieved using one of a number of techniques, such as through fast Fourier transform (FFT) with appropriate averaging and peak frequency component detection. The CFAT module 740 may provide a frequency error input to the frequency offset removal module 720. The CFAT module 740, in some embodiments, also provides a control output for the local oscillator (LO) frequency offset output, that may be used with data from the frame synchronization and interface module 760. A carrier phase tracking and recovery module 750 may use a feed-forward algorithm with a block phase estimator and a phase rotation function to remove residual frequency and phase errors. The carrier phase tracking and recovery module 750 may operate on the on-time data samples produced by the PMD compensation module. A differential decoder 755 may be responsible, in various embodiments, for accepting symbol streams from the carrier phase tracking and recovery module 750 (e.g., at 1 sample per symbol). The differential decoder 755 may be configured to differentially decode the signal and provide the decoded output (e.g., a hard-decision output data stream) to the frame synchronization and interface module 760. The frame synchronization and interface module 760 processes data to achieve frame synchronization, and may include functional blocks for data alignment, frame sync detection, and clock transfer. The frame synchronization module 760 may be configured to skew, swap, and rotate received channels with respect to each other. In some embodiments the frame synchronization module 760 receives information from unique word identification module 610 to assist in data alignment, frame sync detection, and/or clock transfer.

[0031] **FIG. 8** is a flow chart of a method 800 for digital modulation and encoding of an optical signal according to various embodiments of the invention. The method 800 may be performed by the digital modulation and encoding unit 105 of FIGs. 1 through 3.

[0032] At block 805, incoming data is received. Incoming data may be generated from a data source that provides data to a digital coding and modulation unit, such as unit 105 of FIG. 1. The data source may include any of a number of common data sources, such as a user telecommunications device, a cable operator head-end unit, a telecommunications provider central office, a computer server, or a network attached storage system, to name but a few examples. At block 810, the received data is formatted into packet frames for transmission. The packet frames may conform to one of many common protocols for packet frames used in optical communications systems which commonly include a header and a payload, and possibly a trailer, such as a CRC. As is well understood, the header may be interleaved with the payload during transmission, depending upon the particular protocol being used for optical transmission. At block 815, the stream of packet frames is encoded with forward error correction code (FEC) to generate an encoded but stream. The particular type of FEC information of various embodiments generally includes systematically generated redundant error-correcting code (ECC) data that is transmitted along with the frames, and in an embodiment FEC information includes turbo product code (TPC) information. The FEC information may be interleaved with the frames of data to reduce the likelihood of a channel error removing all FEC data for a particular frame. At block 820, a unique word is inserted into the encoded bit stream for each transmitted optical channel. Such unique words may assist with the decoding and demodulation of the optical signals containing different streams of data. In one embodiment, the interleaved frames of data are modulated using dual-polarity (dual-pole) quadrature-phase-shift-keying (QPSK), resulting in four optical channels, with a unique word inserted into the data stream for each of the four optical channels. Differential encoding may be applied to the bit stream either before or after the addition of the unique words. The encoded data streams and unique words transmitted over an optical fiber connection, as indicated at block 825. Transmission may be performed in the optical domain via dual-pole QPSK modulation, resulting in four parallel optical streams. Other modulation schemes may be used in other examples, as well.

[0033] **FIG. 9** is a flow chart of a method for digital demodulation of an optical signal according to various embodiments of the invention. The method 900 may be performed by

the digital demodulation and decoding unit 125 of FIG. 1 or 6. More specifically, the method 900 may be performed by the demodulator unit 615, or 700 of FIG. 6 or 7, respectively.

[0034] At block 905, a digitized version of an optical signal is received, including four parallel streams: a horizontal in-phase (HI) stream, a vertical in-phase stream (VI), a horizontal quadrature (HQ) stream, and a vertical quadrature (VQ) stream. At block 910, a unique word in each of the four parallel streams is identified. At block 915, characteristics of the parallel data streams are determined based on the identification of the unique words. Such characteristics may include, for example, the particular received channel on which the unique words are identified, and the timing of the receipt of the unique words. At block 920, the data streams are demodulated into data transport frames using, in part, characteristics of the optical signals determined using the identified unique words. In various embodiments, one or more modules within an demodulator and decoder may receive one or more measured characteristics of the parallel data streams that were determined based on the identification of the unique words, which may be used to assist in the demodulating and/or decoding of the received optical channels.

[0035] These components may, individually or collectively, be implemented with one or more Application Specific Integrated Circuits (ASICs) adapted to perform some or all of the applicable functions in hardware. Alternatively, the functions may be performed by one or more other processing units (or cores), on one or more integrated circuits. In other embodiments, other types of integrated circuits may be used (e.g., Structured/Platform ASICs, Field Programmable Gate Arrays (FPGAs) and other Semi-Custom ICs), which may be programmed in any manner known in the art. The functions of each unit may also be implemented, in whole or in part, with instructions embodied in a memory, formatted to be executed by one or more general or application-specific processors.

[0036] It should be noted that the methods, systems and devices discussed above are intended merely to be examples. It must be stressed that various embodiments may omit, substitute, or add various procedures or components as appropriate. For instance, it should be appreciated that, in alternative embodiments, the methods may be performed in an order different from that described, and that various steps may be added, omitted or combined. Also, features described with respect to certain embodiments may be combined in various other embodiments. Different aspects and elements of the embodiments may be combined in a similar manner. Also, it should be emphasized that technology evolves and, thus, many of

the elements are exemplary in nature and should not be interpreted to limit the scope of the invention.

[0037] Specific details are given in the description to provide a thorough understanding of the embodiments. However, it will be understood by one of ordinary skill in the art that the embodiments may be practiced without these specific details. For example, well-known circuits, processes, algorithms, structures, and techniques have been shown without unnecessary detail in order to avoid obscuring the embodiments.

[0038] Also, it is noted that the embodiments may be described as a process which is depicted as a flow diagram or block diagram. Although each may describe the operations as a sequential process, many of the operations can be performed in parallel or concurrently. In addition, the order of the operations may be rearranged. A process may have additional steps not included in the figure.

[0039] Moreover, as disclosed herein, the term "memory" may represent one or more devices for storing data, including read-only memory (ROM), random access memory (RAM), magnetic RAM, core memory, magnetic disk storage mediums, optical storage mediums, flash memory devices or other computer-readable mediums for storing information. The term "computer-readable medium" includes, but is not limited to, portable or fixed storage devices, optical storage devices, wireless channels, a sim card, other smart cards, and various other mediums capable of storing, containing or carrying instructions or data.

[0040] Furthermore, embodiments may be implemented by hardware, software, firmware, middleware, microcode, hardware description languages, or any combination thereof. When implemented in software, firmware, middleware or microcode, the program code or code segments to perform the necessary tasks may be stored in a computer-readable medium such as a storage medium. Processors may perform the necessary tasks.

[0041] Having described several embodiments, it will be recognized by those of skill in the art that various modifications, alternative constructions, and equivalents may be used without departing from the spirit of the invention. For example, the above elements may merely be a component of a larger system, wherein other rules may take precedence over or otherwise modify the application of the invention. Also, a number of steps may be undertaken before, during, or after the above elements are considered. Accordingly, the above description should not be taken as limiting the scope of the invention.

WHAT IS CLAIMED IS:

1. A system, apparatus, or method as described in the Specification and/or Drawings.

ABSTRACT OF THE DISCLOSURE

Methods, systems, and devices are described for formatting of data streams to be transmitted over fiber optic channels, and for processing received optical signals. An exemplary data transmission device may include a digital coding and modulation module that encodes a digital data stream, inserts unique words into the digital data stream, and modulates the encoded data stream and unique words onto a plurality of optical channels for transmission over an optical fiber. An exemplary demodulator and decoding device may include a unique word identification module that identifies the unique words inserted in each optical channel stream, determines one or more characteristics of the plurality of optical channels based on the unique words, and provides the one or more characteristics to one or more other modules in the demodulator and decoding device.

5198130_1.DOC

Title: FRAME FORMATTING FOR HIGH RATE OPTICAL COMMUNICATIONS
Inventor: Dave et al.
Attorney Docket No.: P001.12 (78120.0014)
Client Ref. No.: FCC-0452-US-12
Sheet 1 of 9

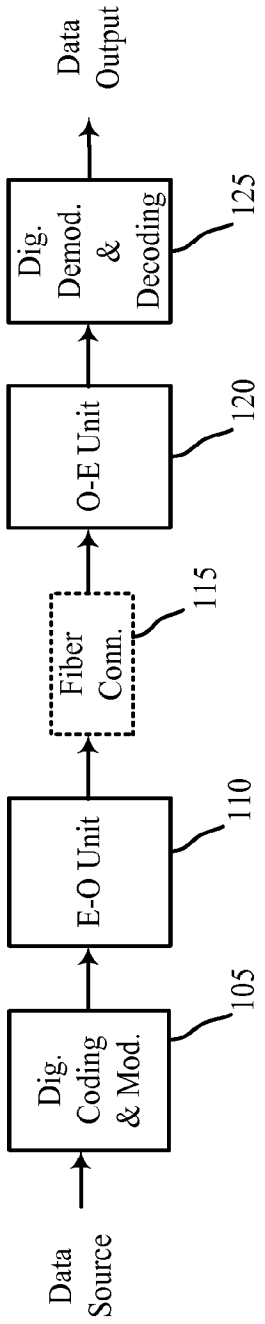


FIG. 1

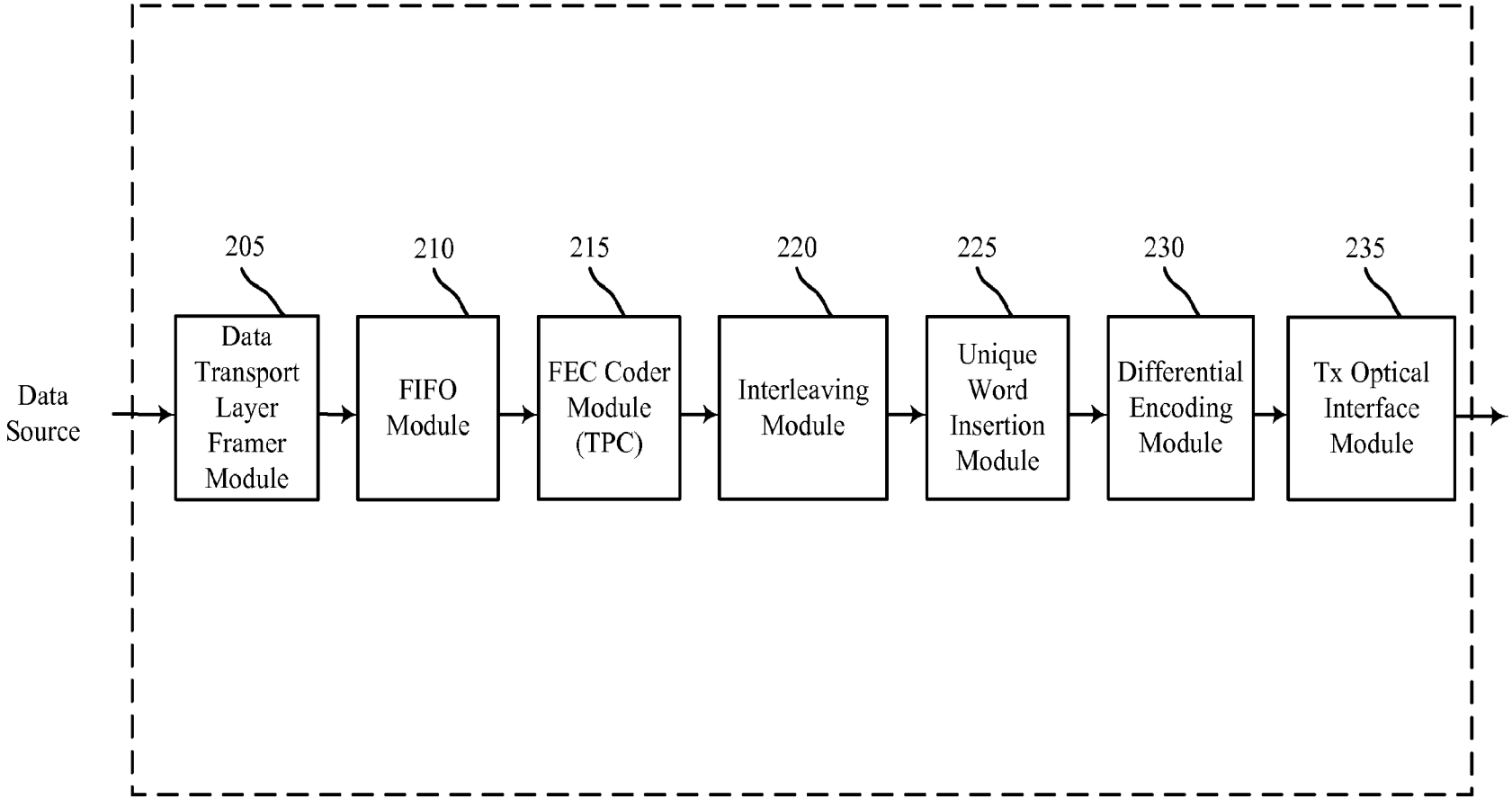


FIG. 2

105-a

Title: FRAME FORMATTING FOR HIGH RATE OPTICAL COMMUNICATIONS
Inventor: Dave et al.
Attorney Docket No.: P001.12 (78120.0014)
Client Ref. No.: FCC-0452-US-12
Sheet 3 of 9

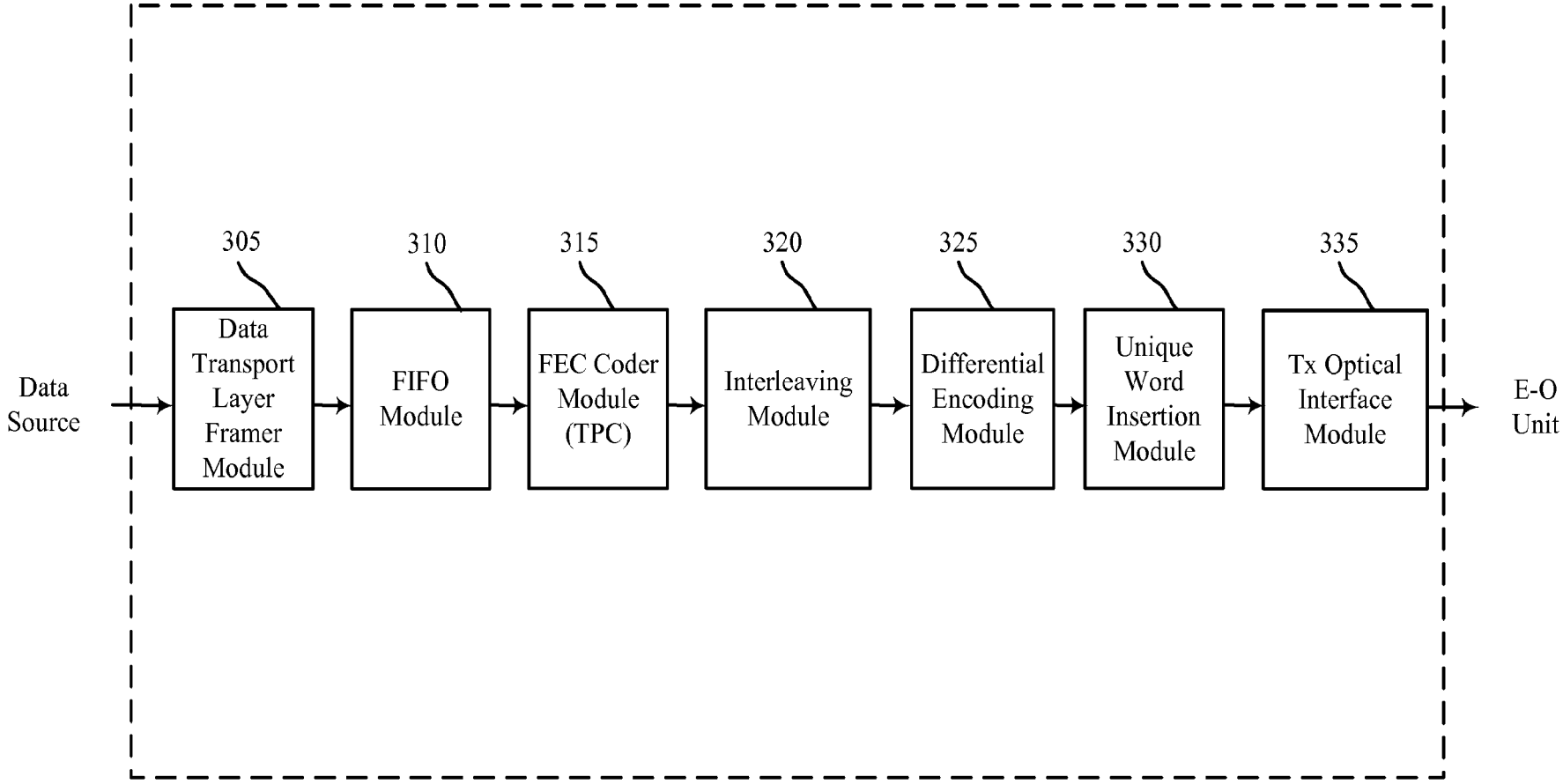


FIG. 3

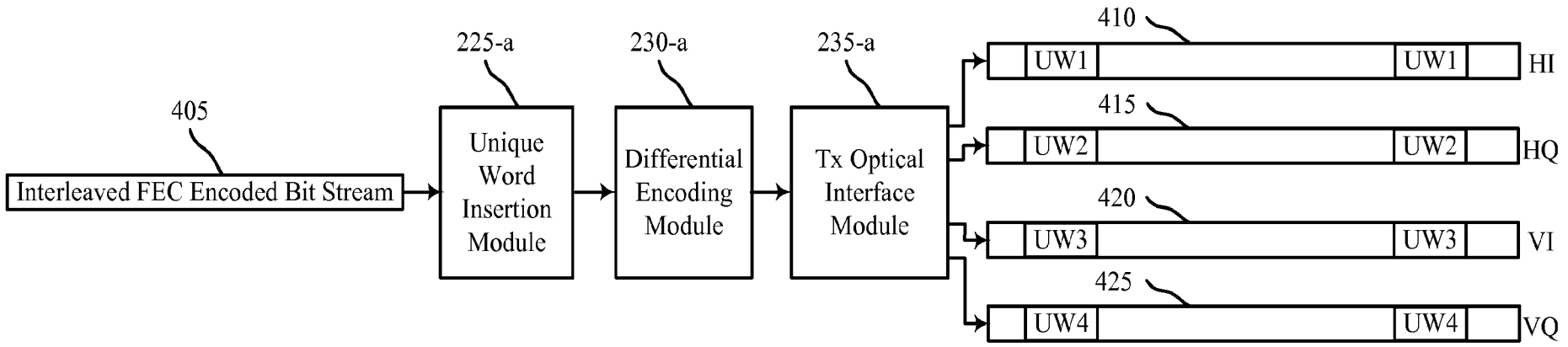
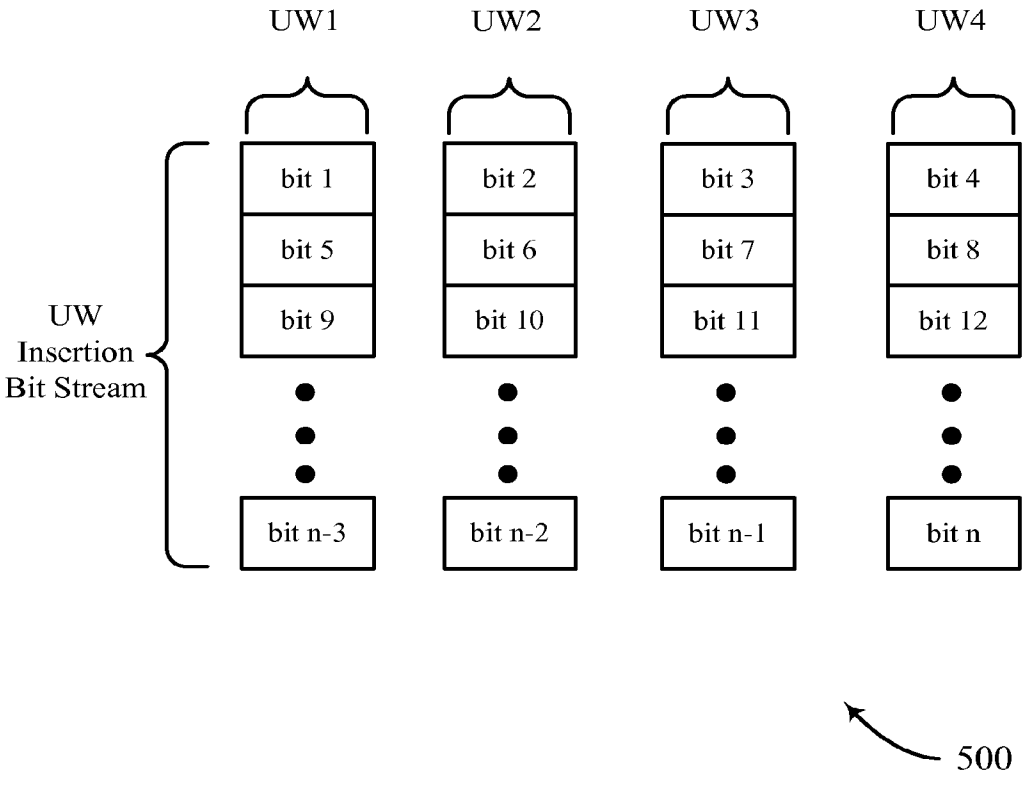


FIG. 4

400

Title: FRAME FORMATTING FOR HIGH RATE OPTICAL COMMUNICATIONS
Inventor: Dave et al.
Attorney Docket No.: P001.12 (78120.0014)
Client Ref. No.: FCC-0452-US-12
Sheet 4 of 9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UW2
UW3
UW4
UW Insertion Bit Stream
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bit 2
bit 3
bit 4
bit 5
bit 6
bit 7
bit 8
bit 9
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bit n-3
bit n-2
bit n-1
bit n
500

FIG. 5

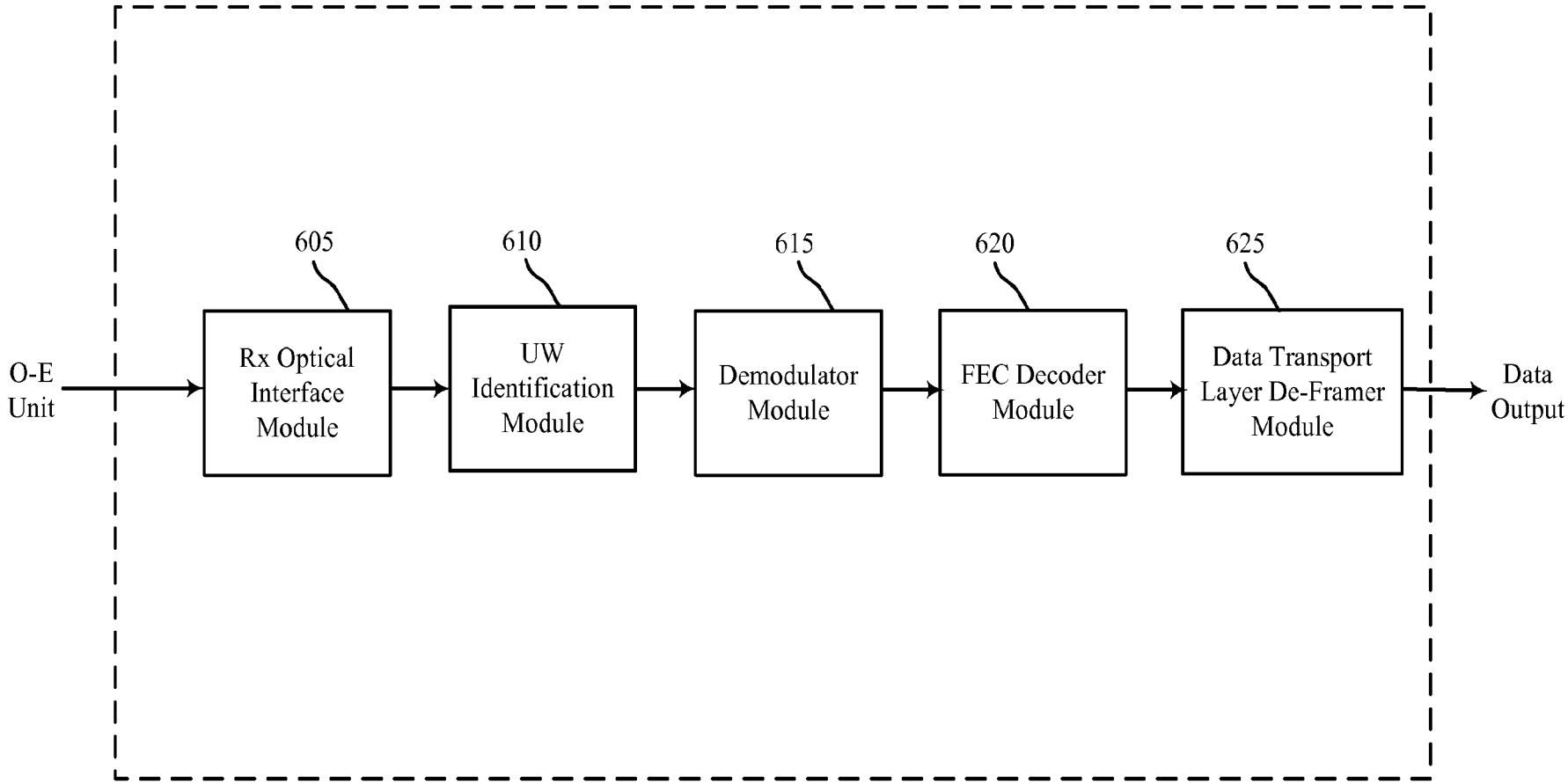

FIG. 6

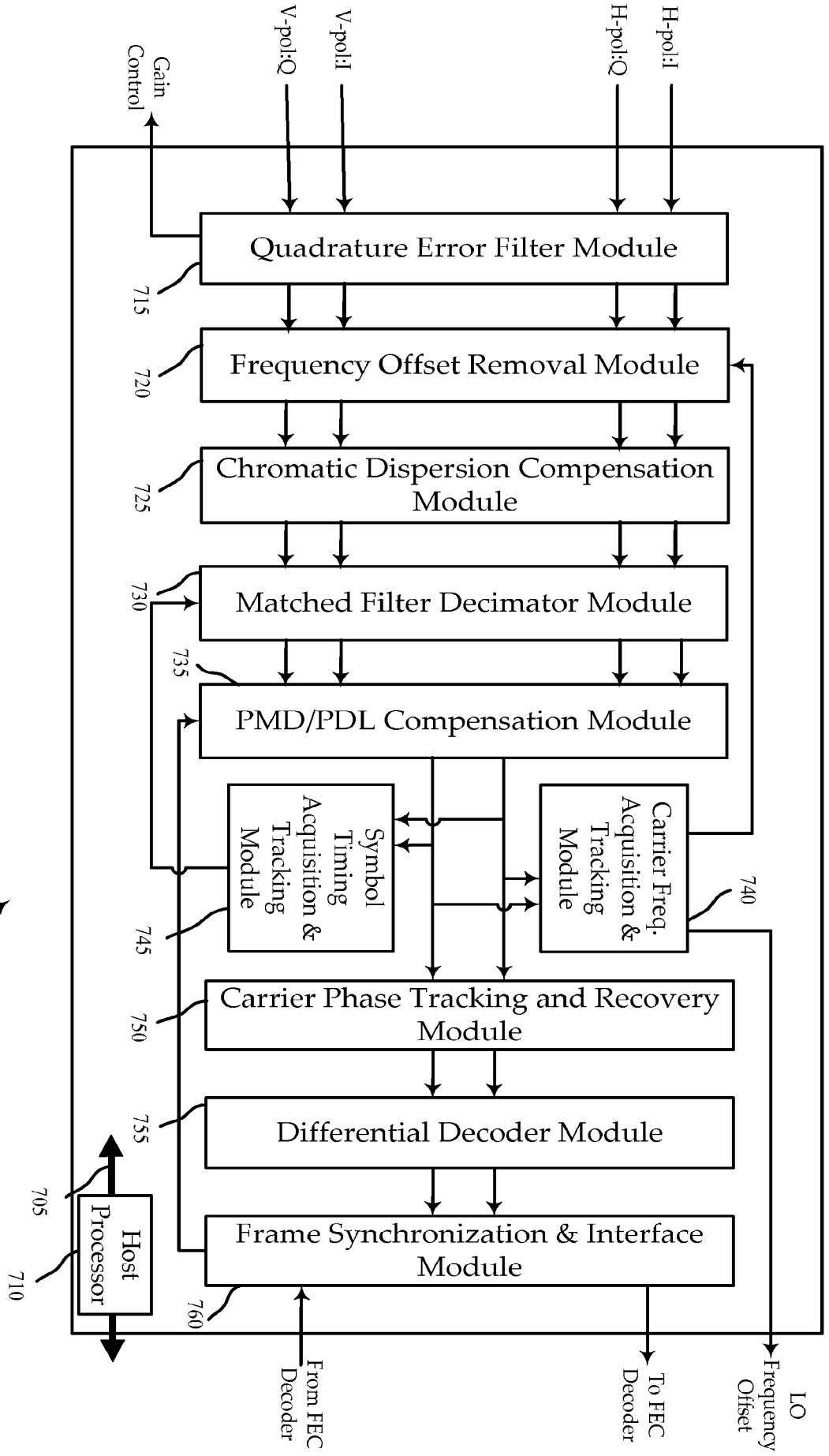

FIG. 7

700

Sheet 7 of 9

Attorney Docket No.: P001.12 (78120.0014)
Client Ref. No.: FCC-0452-US-12

Title: FRAME FORMATTING FOR HIGH RATE OPTICAL COMMUNICATIONS
Inventor: Dave et al.

[Exhibit 2-101]

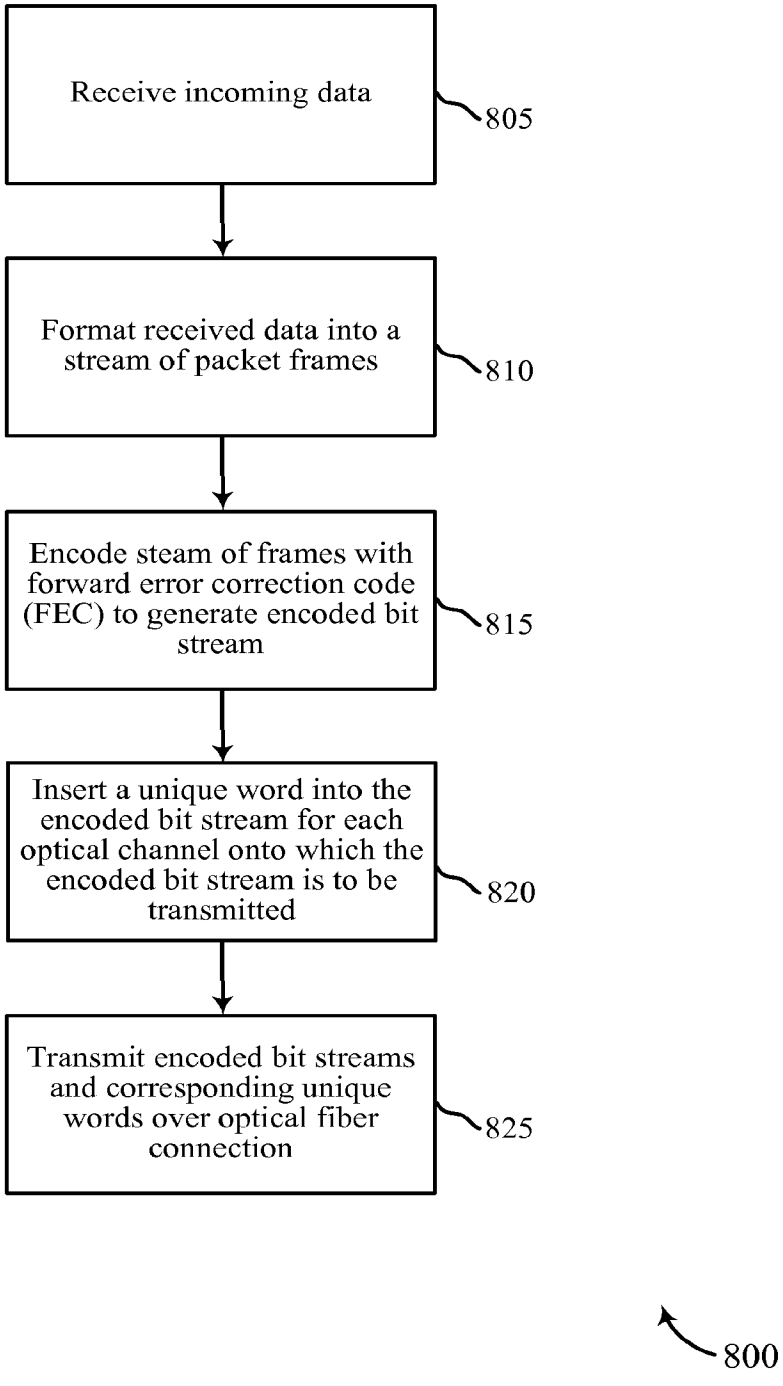
Receive incoming data
805
Format received data into a stream of packet frames
810
Encode steam of frames with forward error correction code (FEC) to generate encoded bit stream
815
Insert a unique word into the encoded bit stream for each optical channel onto which the encoded bit stream is to be transmitted
820
Transmit encoded bit streams and corresponding unique words over optical fiber connection
825
800

FIG. 8

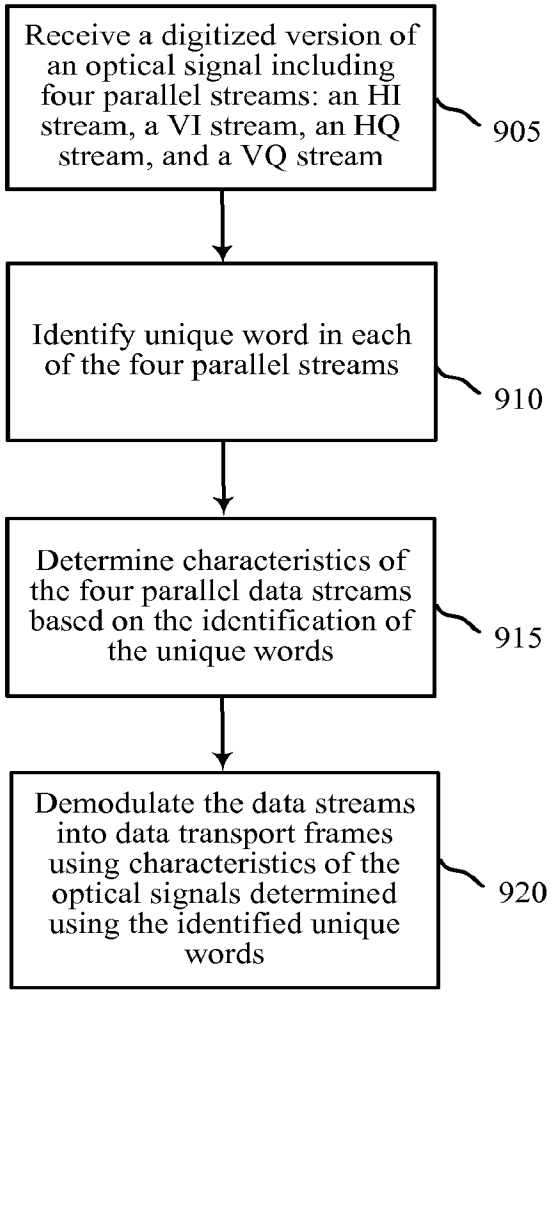
Receive a digitized version of an optical signal including four parallel streams: an HI stream, a VI stream, an HQ stream, and a VQ stream
905
Identify unique word in each of the four parallel streams
910
Determine characteristics of the four parallel data streams based on the identification of the unique words
915
Demodulate the data streams into data transport frames using characteristics of the optical signals determined using the identified unique words
920
900

FIG. 9

Electronic Patent Application Fee Transmittal

Application Number:	
Filing Date:	
Title of Invention:	FRAME FORMATTING FOR HIGH RATE OPTICAL COMMUNICATIONS
First Named Inventor/Applicant Name:	Fan Mo
Filer:	Michael L. Drapkin/Sherry Soares
Attorney Docket Number:	P001.12 (78120.0014)

Filed as Large Entity

Provisional Filing Fees

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Provisional application filing	1005	1	220	220
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				

[Exhibit 2-104]

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Miscellaneous:				
		Total in USD ($)		**220**

[Exhibit 2-105]

Electronic Acknowledgement Receipt

EFS ID:	10690916
Application Number:	61521263
International Application Number:	
Confirmation Number:	1904
Title of Invention:	FRAME FORMATTING FOR HIGH RATE OPTICAL COMMUNICATIONS
First Named Inventor/Applicant Name:	Fan Mo
Customer Number:	16565
Filer:	Michael L. Drapkin/Sherry Soares
Filer Authorized By:	Michael L. Drapkin
Attorney Docket Number:	P001.12 (78120.0014)
Receipt Date:	08-AUG-2011
Filing Date:	
Time Stamp:	18:50:48
Application Type:	Provisional

Payment information:

Submitted with Payment	yes
Payment Type	Deposit Account
Payment was successfully received in RAM	$220
RAM confirmation Number	5578
Deposit Account	082623
Authorized User	

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

Charge any Additional Fees required under 37 C.F.R. Section 1.17 (Patent application and reexamination processing fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.21 (Miscellaneous fees and charges)

[Exhibit 2-106]

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Provisional Cover Sheet (SB16)	P00112_78120-0014_ProvisionalCover.pdf	1060274 5fa3f5f1a6e5db8462b9131c182bcac6dc5758f2	no	3
Warnings:					
Information:					
2	Application Data Sheet	P00112_78120-0014_ADS.pdf	1031493 d85e93265f0f232b6cbe0a92f3344392ef64a608	no	4
Warnings:					
Information:					
3		P00112_78120-0014_Specification.pdf	116490 5374df3ebdf5782bc3179d46d624e3172be23fe0	yes	16

Multipart Description/PDF files in .zip description

Document Description	Start	End
Specification	1	14
Claims	15	15
Abstract	16	16

Warnings:					
Information:					
4	Drawings-only black and white line drawings	P00112_78120-0014_Drawings.pdf	98960 aaf41f36093a2f0e817cec75a0b8bc3fd9af688a	no	9
Warnings:					
Information:					
5	Fee Worksheet (SB06)	fee-info.pdf	29411 83b64827f1ebf469bda946333be533ec1bf607ae	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	2336628		

[Exhibit 2-107]

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National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.